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ORIGINAL ARTICLE

Attitudes of Secondary School Students in Israel toward the Use of Living Organisms in the Study of Biology

Pinchas Tamir and Aliza Hamo*

Abstract

The study deals with attitudes and views of 456 Israeli students in grades 7, 9, and 11 regarding the use of living animals in research and biology instruction. It was found that most students are interested in studying live animals through direct observation and experiment and feel that this kind of learning is superior to learning from secondary sources. At the same time, however, most students exhibit concern for and affection toward living organisms in general and higher animals, especially pets and "beneficial" animals, in particular. The need to consider both sides of the issue is highlighted, and practical implications and recommendations to biology teachers are suggested.

Introduction

Most of the modern inquiry-oriented biology curricula are based on a firm belief in the superiority of learning through observation and investigation. While much biological observation is divorced from living things and is concerned with physical and chemical processes, there is a growing belief among biology educators that the study of biology "will be of limited value unless combined with careful, thoughtful observation and investigation of living things" (Australian Academy of Science, 1975). In Israel, where the inquiry-oriented curricula in biology are widely used, special supply centers have been established to facilitate the use of living organisms in classrooms. These centers, located in different parts of the country, operate on a low cost subscription basis, and provide the schools with all kinds of organisms such as unicellular animals, microorganisms, peas and tobacco seeds, *Drosophila,* fish, toads and mice (Tamir, 1976*b*; Blum and Silberstein, 1979). Recently, however, biology experimentation in schools, and especially the use of living animals for study purposes, have come under at-

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tack in a number of countries (e.g Paterson, 1979). There are already signs that in order to avoid legal and social pressures, teachers conveniently abandon the use of living animals altogether (A.J. Barker, personal communication).

It may be argued that plants and microorganisms can often serve as an adequate substitute for animals. Many teachers prefer the use of plants for observations and experiments mainly because plants are easy to use and maintain and, compared with animals, their behavior is much more predictable (Tamir, 1976a). However, there are certain areas, such as movement, adaptation of animals to their environment, the structure and function of animals, and animal behavior, which are unique to animals and therefore may have no substitutes. In addition, many studies have shown that children of different ages prefer to study, observe, and experiment with animals (e.g. Green, 1958; Blanc, 1958; Jungwirth, 1973; Tamir and Jungwirth, 1974).

Both positive and negative outcomes of using living organisms in the classroom have been reported (Stevens, 1970; Kelly and Wray, 1975; Silberstein *et al.*, 1978). It is therefore extremely important to consider carefully the emotional, ethical and pedagogical aspects involved in using living organisms in order to provide some guidelines to teachers and schools. Within this framework, the study of students' opinions on various aspects related to the use of living animals in their biology studies appears highly desirable.

A pilot study which involved 126 high school students in Israel (Tamir and Sever, 1980) served as the basis for the present study. The rationale for these studies is that if teachers become aware of their students' views, they will be able to take these views into consideration in their planning and in making decisions about instructional practices.

Purpose of Study

1. To examine opinions and attitudes of students toward various aspects of using living animals in the study of biology.
2. To identify the attitudes of students toward the use of different kinds of organisms in their studies.
3. To study the effects of selected background variables (age, sex, and religious affiliation) on the attitudes mentioned above.

Procedure

The subjects were 456 high school biology students who studied in 9 schools in the city of Jerusalem. There were 3 religious schools (N = 150) and 6 secular schools (N = 306). 114 studied in grade 7, 144 in grade 9, and 198 in grade 11.

The students responded anonymously to the questionnaire in May 1979. Some of the teachers who administered the questionnaire failed to remind the students to mark their sex on the questionnaire. Consequently the information regarding the sex of students was obtained in five classes only, which were comprised of 89 boys and 93 girls. There is no reason to assume that the students in these classes were different from the rest of the subjects. Therefore there is no reason to omit the comparisons made between boys and girls even though the data pertains only to 40% of the total sample.

The questionnaire consisted of 4 parts as follows:

Part A consisted of 40 statements to which the subject responded on a 5 point scale in which 1 = don't agree and 5 = fully agree (See Table 1). The first 10 statements were identical to those used by Tamir and Sever (1980). The other 30 statements were designed according to the responses of 126 students to the open question "What do you think about the use of animals in experiments and dissections while learning biology in school?"

Part B described an experiment in which the fins of a fish are removed in order to study the effect on swimming and to observe the capability of animals to compensate for missing structures. (This experiment was taken from a seventh grade textbook widely used in Israel.) The subjects had to choose one or more out of four possible responses (see Table 3). It should be noted that the fins of the fish *Tilapia*, which is used in the 7th grade program in Israel, eventually regenerate.

Part C consisted of a list of 20 organisms, 4 plants and 16 animals, mixed in random order. These organisms were grouped for the purpose of analysis as follows: plants (pine tree, fern, carrot, orange), lower animals (worms, ants, flies), "harmful" animals (mouse, poisonous snake, bat), "neutral" animals (lizard, frog, rabbit, pigeon), "beneficial" animals (black snake, chicken, goat), and pets (cat, dog, fish). The subjects were asked to indicate which of these animals they would use in experiments which could cause irreversible damage to the animals.

Part D required the subjects to choose one or more out of four possible responses (see Table 6) to the statement: "You are assigned to dissect a mouse and implant in it an organ taken from another mouse."

The results were analyzed by computer programs yielding frequency distributions, X^2, means and standard deviations, correlations and analysis of variance.

Results and Discussion

Table 1 presents the responses to Part A. As may be seen, only 6% of the respondents did not like to study biology. Since most of the students liked to study biology, and most of them preferred to study animals (see item 2), the responses to the various questions in the present study, even negative ones, should not be regarded as a consequence of a general reservation about the study of biology, but rather as a genuine expression of attitudes toward the specific issues at hand. Items 3 to 40 were grouped according to their content into seven subtests. Table 2 presents the mean responses to the subtests arranged in descending order.

Table 2 shows that, in general, students regard experiments with and observations of animals to be important. On the average, they also favor the use of animals for instructional purposes and they value the positive motivational effects of such instruction. At the same time, however, they express sincere concern for and affection toward animals.

The results show a number of attitudes which on the surface appear to be contradictory. A few examples taken from Table 1 will be mentioned. While 72 percent did not agree that experiments that involve long-term suffering were

TABLE 1—Means, Standard Deviations and Response Distribution in Part A (in percents, N = 456)

	Statement	Don't agree 1+2	Agree 4+5	X on a 5 point scale	S.D.
1.	I like to study biology.	5.9	81.4	4.29	0.98
2.	The study of plants is more interesting than the study of animals.	69.1	11.6	1.97	1.15
3.	It is important to observe animals in nature.	5.7	78.5	4.33	0.99
4.	It is important to make experiments with animals in the laboratory.	18.8	65.8	3.82	1.33
5.	One may experiment with animals as long as they do not suffer.	19.7	61.8	3.76	1.42
6.	Experiments with animals are justified even when they involve long-term suffering.	72.2	13.6	1.91	1.28
7.	Experiments with animals which are essential to human medicine are justified even when they involve long-term suffering.	13.8	72.2	4.04	1.19
8.	Laboratory observation of animals may be allowed provided that the animals are returned to their natural habitat.	10.8	75.7	4.20	1.24
9.	Any experiment which involves animals is more interesting and should therefore be performed.	31.1	44.1	3.18	1.44
10.	Students should perform experiments with animals since in this way they learn much more than by reading books.	17.3	69.1	3.89	1.34
11.	Teachers' demonstrations should be preferred over students' experiments with animals.	44.6	41.2	2.91	1.60
12.	Experiments with animals increase our scientific knowledge and contribute to the care of animals as well as to that of people.	17.5	66.7	3.86	1.34
13.	Information gained through dissection of animals may help the survival of mankind by improving the medical treatment of people.	31.1	47.4	3.19	1.47
14.	Only animals which have a high rate of reproduction should be used in experiments and dissections.	10.7	74.3	4.13	1.22
15.	It is not desirable to substitute experiments with animals by demonstrations, films, and TV.	28.9	73.9	3.28	1.40
16.	Experiments with plants should generally be preferred to experiments with animals.	19.6	64.5	3.81	1.41
17.	Only animals which are harmful to man should be used in experiments and dissections.	48.0	32.3	2.67	1.51
18.	The use of rare animals in experiments and dissections should be avoided.	9.0	85.8	4.45	1.12
19.	Experiments in TV and films should be preferred since the damage to animals is restricted to a very few.	26.5	49.8	3.38	1.42
20.	Students lack competence and skills and therefore they should not perform experiments and dissections of animals by themselves.	41.4	39.5	2.93	1.47

	Statement	Don't agree 1+2	Agree 4+5	X on a 5 point scale	S.D.
21.	Experiments with animals may help learning slightly, but the damage to animals is severe; therefore experiments should be highly restricted.	47.3	30.9	2.72	1.45
22.	Generally, dissections are not interesting, so why kill innocent animals?	69.3	17.8	2.00	1.36
23.	One should not experiment with animals just to make it more interesting for students.	27.8	53.0	3.48	1.47
24.	The view that one can treat animals as one wishes is fundamentally wrong.	19.1	67.7	3.89	1.40
25.	Any experiment with animals is cruel, since animals also have feelings and souls.	25.0	51.1	3.47	1.36
26.	Any creature has the right to live peacefully without interruptions.	10.3	72.1	4.07	1.19
27.	When human beings benefit, the killing of animals is permitted, even by the Torah.	38.3	36.2	2.92	1.45
28.	People depend on animals, therefore we should be grateful rather than kill them.	36.8	32.2	2.93	1.32
29.	Only animals which endanger people may be damaged by dissection and experiments.	53.3	26.6	2.50	1.50
30.	Material learned by experiments with animals is internalized and understood much better.	9.4	74.1	4.11	1.16
31.	One may deny feeding vitamins to chickens in order to study the effect of this deficiency on their growth.	26.7	50.0	3.34	1.37
32.	The student should not rely on secondary sources; he should examine and study animals directly.	41.2	35.5	2.84	1.44
33.	It is acceptable to cause temporary damage, provided that the animals recover their original state.	15.3	66.7	3.84	1.29
34.	Experiments with animals motivate students to continue and learn about these animals.	16.9	65.7	3.77	1.27
35.	Reading reports by scientists about their experiments with animals is better than actually doing the experiments.	49.8	26.5	3.62	1.40
36.	Experiments with animals are exciting and therefore what is learned is remembered for a long time.	16.6	70.8	3.96	1.31
37.	Observations and experiments with animals help me to understand better my relations with my friends.	65.4	16.9	2.12	1.31
38.	Doing an experiment with or dissection of animals brings a lot of satisfaction.	35.4	43.4	3.11	1.45
39.	Fish are sold in the market and many insects are pests—therefore they may be used for experiments as well.	45.2	26.1	2.64	1.38
40.	People kill animals anyway (food, hunting), so the use of animals in experiments does not make any difference.	64.9	17.6	2.14	1.33

TABLE 2—Mean Scores and Standard Deviations in Different Subtests of Part A† (N = 456)

Subtests related to the use of animals	Items	No. of Items	Score on a 5 point scale X	S.D.
Use of animals in research	7, 12, 13, 17, 18, 29	6	3.62	.77
Importance for learning	10, 21, 30, 32, 35	5	3.50	.87
Importance of observations and experiments	3, 4, 5, 6	4	3.46	.66
Use of animals in instruction	8, 16, 31, 33	4	3.39	.69
Motivation to learn, interest	9, 22, 23, 34, 36, 37, 38	7	3.23	.74
Importance of actual students' performance of experiments	11, 15, 19, 20	4	3.06	.74
Valuing the life of animals	24, 25, 26, 28, 39, 40	6	2.40	.73
Whole inventory		38	3.23	.42

† In order to obtain meaningful subtests' scores in which 'high' means favoring direct handling of animals, the negative items were reversed.

justified (item 6), 72 percent agreed with statement 7 that such experiments are justified if the suffering is essential to human medicine. The comparison of the responses to items 6 and 7 may be interpreted as indicating that human health has top priority in the values of most students.

Another example of contradictory answers relate to items 8, 14, 18, 24 and 26 which reveal that most students express sincere concern for and affection toward animals. Thus, most students believe that it is fundamentally wrong to treat animals as one wishes (item 24) and that any creature has the right to live peacefully without interruption (item 26) and, therefore, experiments should not be performed just to make the class more interesting (item 23). On the other hand, almost 67 percent of the students agreed that it is acceptable to cause temporary damage to animals (item 33). This contradiction may be explained by suggesting that most students care for animals and would avoid hurting them unless there is a good cause to justify their use. Even then they would attempt to minimize the damage to animals. The conflict between the recognition of the importance of working with animals on the one hand, and the desire to avoid unnecessary damage to them on the other hand, is also apparent in their responses to statements about learning. Thus, items 10, 15, 22, 30, 34, 35, and 36, certainly favor learning based upon the use of living animals, while items 9, 11, 14, 16, 19, 23, 24, and 25 show that even students who favor the use of animals are concerned about the possible damage to and interference with the lives of animals. This ambivalence has important implications, to be discussed later.

T tests revealed no statistically significant differences, either between boys and girls or between students in secular and religious schools. Analysis of variance revealed a few statistically significant differences by grade level. Thus 7th grade students when compared with 9th and 11th grade students had a lower mean score on the following subtests: Use of animals in research ($F = 5.66$, $p < 0.01$); Importance for learning ($F = 8.95$, $p < 0.01$); and Importance of actual students' performance of experiments ($F = 5.79$, $p < 0.01$). In the last two subtests 11th grade students had higher mean scores than 9th grade students, and the difference as estimated by the Duncan range test was statistically significant at the 0.05 level. It may be concluded that younger children are more sensitive to the use of animals and that as they grow older they tend to value more the use of animals both in research and in instruction.

Table 3 presents the responses related to the experiment involving the removal of the fins of a fish. The results in Table 3 are almost identical with those obtained in the pilot study (Tamir and Sever, 1980), namely, more than half of the students were ready to perform the experiment while only 11% declared categorically that they would not perform the experiment. It is interesting to note that significantly more 7th grade students, whose curriculum requires the performance of this particular eperiment, voted against it. Seventh grade teachers should take this attitude into serious consideration in their planning and instruction. This particular experiment would not have been permitted in British schools because of the clearcut avoidance of vivisection in these schools (J.A. Barker, personal communication).

In the pilot study it was found that students differ in their attitudes toward 12 different animals (Tamir and Sever, 1980). The same 12 animals were included in the present study. Two changes and two additions were made as follows: a) In-

TABLE 3 — Distribution of Students' Responses to Various Options Related to an Experiment in which the Fins of Fish are Removed in Order to see the Effect on Swimming (in percents)

	Suggested Option*	Whole Sample N = 456	Grade Level 7 N = 114	9 N = 144	11 N = 198	χ^2
A.	I would not perform such an experiment because the fish would suffer.	11.2	17.5	8.3	9.6	6.32†
B.	I would perform the experiment because it is interesting and the damage to the fish is temporary.	55.0	42.0	61.1	58.1	10.59‡
C.	I prefer to use plants to demonstrate compensation (e.g. regeneration in Acetabularia).	24.6	28.1	17.4	27.8	5.90†
D.	I prefer to use substitutes such as films or television programs.	17.1	23.7	17.4	13.1	5.69

* More than one option could be marked

† $p < 0.05$

‡ $p < 0.01$

TABLE 4 — Percentage of Students Favoring Experiments causing Irreversible Damage to Different Organisms† (N = 456)

Plants		"Lower" animals		"Harmful" animals		"Neutral" animals		Pets		"Beneficial" animals	
Whole group	63	Whole group	64	Whole group	41	Whole group	43	Whole group	17	Whole group	17
Carrot	74	Worms	68	Mouse	51	Frog	44	Fish	34	Black snake	29
Orange	73	Flies	66	Poisonous snake	46	Lizard	41	Rabbit	18	Chicken	12
Fern	53	Ants	57	Bat	27			Cat	13	Goat	10
Pine	52							Pigeon	11		
								Dog	8		

† In each group the organisms are arranged by percentage of agreement in descending order.

stead of *snake* in the pilot study we have *black snake* and *poisonous snake;* b) *flies and ants* which appeared as one item in the pilot study are separated here; c) *bats* and *fish* were added; d) four plants were added to see whether or not the assumption that students have no reservations regarding the use of plants is valid.

Table 4 presents the results for individual organisms as well as for groups of organisms. The groups were formed post hoc for the purpose of analysis. Table 4 shows that as far as experiments that cause irreversible damage are concerned, students view plants and lower animals to be alike, and about two-thirds of them favor such experiments. The fact that about half of the students are opposed to causing irreversible damage to ferns and pines while only a quarter are against using carrots and oranges, may be a result of the fact that the latter are eaten and the former are normally not eaten. The results suggest that even plants should not be assumed to be suitable for any kind of treament in a biology course.

As far as animals are concerned, it is very clear that the use of pets and useful animals should be restricted to a minimum. Students are more tolerant of the use of "harmful" animals or of "neutral" animals such as frogs and lizards. The relatively low percentage regarding bats may be a result of the unfamiliarity of many students with this particular kind of animal.

Comparison of the mean response scores regarding different groups of organisms revealed no statistically significant differences between students in religious and in secular schools. As to grade level, students in 7th grade were less inclined than 9th and 11th grade students to cause irreversible damage to plants and to lower animals (F values obtained were 7.10 ($p < 0.001$) and 2.94 ($p < 0.05$) respectively). Compared with girls, boys had a higher mean score in favor of the use of plants, lower animals, and "harmful" animals (t values obtained were, resepectively, 2.13, 2.21, 1.97, $p < 0.05$). There were no statistically significant differences between boys and girls regarding the use of "neutral" animals, pets, and "useful" animals.

Statistically significant differences pertaining to particular organisms are presented in Table 5. It may be observed that while, as mentioned above, younger students had more reservations about the unrestricted use of plants and lower animals, older students were less inclined to sacrifice frogs and bats. Students in religious schools were more inclined to sacrifice pines and poisonous snakes, while students in secular schools exhibited more care for ferns. As already indicated, in all cases where statistically significant differences were found between the sexes, boys showed a higher level of readiness to do experiments which involve irreversible damage. Teachers should take into consideration the possible special sensitivity of girls.

Table 6 presents the results on the readiness of students to perform an operation on a mouse. The results show that two-thirds of the students were willing to perform such an operation, while one-fifth were not. Significantly more 7th grade students were reluctant to operate. Perhaps one may conclude that even operations on "harmful" animals are not desirable to a significant proportion of the students and that even if operations and dissections are necessary they should be postponed at least until the students have reached the 9th grade. It is interesting to note that relatively more students in religious schools were not ready to perform the operation. There were no statistically significant differences between boys and girls in their responses to this question.

TABLE 5—Percentage of Students in Different Groups Favoring the Use of Specific Organisms in Experiments which cause Irreversible Damage*

Organisms	Whole Sample N = 456	Grade Level 7 N = 114	9 N = 144	11 N = 198	χ^2	School Type Religious N = 150	Secular N = 306	χ^2	Sex Male N = 89	Female N = 93	χ^2
Pine tree	52	42	56	55	6.03†	60	48	5.30†			
Fern	53	40	50	62	13.71‡	48	57	5.22			
Carrot	74	64	75	78	7.76†				89	74	5.43†
Orange	72	64	76	76	5.91†				84	71	3.88†
Flies	66	55	70	68	7.29†				75	58	5.30†
Frog	44	54	43	39	14.53‡						
Bat	27	33	19	30	7.45†				34	19	4.11†
Poisonous snake	46					53	42	4.07†			
Pigeon	9								14	4	3.71†

* Only statistically significant differences are reported
† $p < 0.05$
‡ $p < 0.01$

TABLE 6—Distribution of Students' Responses to the Alternatives Regarding the Mouse Operation (in percents)*

	Alternative	Whole Sample N = 456	Grade level 7 N = 114	9 N = 144	11 N = 198	χ^2	School Type Religious N = 150	Secular N = 306	χ^2
A.	I think that an anesthetized mouse may be operated upon since it will not suffer.	23	28	18	24	8.19	17	26	3.54
B.	I would not operate on even an anesthetized mouse because it may not survive.	20	37	17	12	29.81‡	25	17	8.91†
C.	I would perform the operation for a scientific purpose such as clarifying issues that may help humanity and its health.	64	43	70	71	27.91‡	62	64	0.15
D.	I like to anesthetize and operate upon animals since this prepares me to become a good physician.	4	4	3	5	2.54	4	4	0.78

* Students were able to choose more than one alternatve
† $p < 0.05$
‡ $p < 0.001$

Summary and Implications

The responses of students reveal a high level of personal involvement regarding different aspects related to the use of live animals in school. This attitude stems from the high level of interest that most children have in animals, as well as from the personal relations that many children have developed with animals. Many children possess empathy, a kind of identification with animals, especially pets and farm animals such as cats, dogs, and goats. It is interesting to note that while this empathy is very high toward higher and "useful" animals, many students express empathy also toward lower animals. For example 45 percent of the students do not agree with using fish and insects in experiments even though fish are sold in the market and many insects are pests (Table 1, item 39). Similarly Table 4 shows that 32 to 43 percent of the students would not favor causing irreversible damage to lower organisms. As personal feelings and empathy diminish, logical considerations play more and more of a decisive role. This is evidenced by the relatively high level of consent to the use of mice in operations and experiments. While 74% would not concede as a general practice to substitute experiments with animals by demonstrations, films and TV (Table 1, item 15), 50% would prefer experiments on TV and films in cases in which the experiments cause damage to the animals, because in these cases filming the experiments will reduce the number of animals damaged (Table 1, item 19).

Thus the attitude of students appears to be somewhat ambivalent. On the one hand, it is clear that most students are keen on having live animals as part of their studies in school and see in their experiences with animals a means for increasing the motivation as well as the efficiency of learning and retention. This general attitude of students, combined with some unique outcomes related to the study of animals, makes a strong case for the use of animals in schools. On the other hand, many students are genuinely concerned about the life and welfare of animals. Thus, teachers should be alert to both positive and negative aspects of experiences with live animals and attempt to emphasize the positive and avoid or diminish the negative. Based on our results we offer the following recommendations: Whenever animal suffering may be caused, the need for the planned activity should be reconsidered and students may be invited to participate in the deliberation. When a positive decision has been made, careless handling of organisms, including plants, should be avoided. When lower or "harmful" animals are capable of serving the instructional objectives their use should be preferred to that of higher and "beneficial" animals. While the general use of substitutes such as films and demonstrations is not recommended, such substitutes may nevertheless be utilized under certain circumstances. Generally, students who are reluctant to perform dissections or operations should not be forced to do so. Certain activities such as dissections may be postponed to upper secondary school levels in order not to upset younger students, especially girls who reveal special sensitivity at the ages of twelve to fourteen.

Administration of questionnaires, such as the one used in the present study, may serve as a basis for class discussion in which important issues related to the use of live animals may be discussed with and by the students. It is hoped that such discussions will make students aware of these aspects and help them to adopt positive attitudes toward live animals and refrain from unnecessary cruelty and other negative behaviors.

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